

# CHAPTER V — SUMMARY OF FORECAST VERIFICATION DATA

## 1. ANNUAL FORECAST VERIFICATION

### a. POSITION FORECAST VERIFICATION

Forecast positions for the warning, 24-, 48-, and 72-hour forecasts are verified against the best track using two criteria:

(1) Only those forecasts for tropical cyclones which reach typhoon intensity and the best track winds are 35 kts or greater are verified; and

(2) All forecasts for which best track positions exist are verified.

The position verification statistics for tropical cyclones meeting criteria (1) above are found in Table 5-1. The 24- and 48-hour errors are essentially the same as the long term mean, however the unusually large 72-hour error is attributable to several extremely erratic storms during the 1974 season. The major problem was failure to correctly forecast recurvature (or non-recurvature) in these storms, resulting in anomalously large 72-hour errors. This same information is depicted graphically in Figure 5-1, with a five year cumulative mean shown which eliminates short term variations. It

TABLE 5-1. JTWC ANNUAL AVERAGE POSITION FORECAST ERROR FOR TYPHOONS WHILE WIND OVER 35 KNOTS

	24-HR	48-HR	72-HR
1950-58	170	---	---
1959	*117	*267	---
1960	177	354	---
1961	136	274	---
1962	144	287	476
1963	127	246	374
1964	133	284	429
1965	151	303	418
1966	136	280	432
1967	125	276	414
1968	105	229	337
1969	111	237	349
1970	98	181	272
1971	99	203	308
1972	116	245	382
1973	102	193	245
1974	114	218	351

\*Forecast positions north of 35°N were not verified.

TABLE 5-2. 1974 JTWC ERROR SUMMARY

(Average errors given in nautical miles)

CYCLONE	WARNING			24 HOUR			48 HOUR			72 HOUR		
	POSIT #	RT #	ANGLE WRNGS	FCST ERROR	RT ERROR	ANGLE #	FCST ERROR	RT ERROR	ANGLE #	FCST ERROR	RT ERROR	ANGLE #
1. TS WANDA	43	33	13	195	117	9	404	189	5	475	270	1
2. TS AMY	31	20	19	136	54	15	---	---	---	---	---	---
3. TS BABE	19	15	21	112	82	17	---	---	---	---	---	---
4. TY CARLA	17	12	20	87	38	16	182	75	11	196	136	7
5. TD 05	31	11	5	73	33	1	---	---	---	---	---	---
6. TY DINAH	29	23	26	126	86	21	193	154	18	343	316	11
7. TS EMMA	26	14	21	115	72	27	240	180	7	371	302	3
8. TS FREDA	36	16	7	114	61	3	---	---	---	---	---	---
9. TY GILDA	20	15	28	66	42	24	65	34	18	109	75	14
10. TS HARRIET	24	16	13	143	112	9	187	98	3	182	41	1
11. TS JEAN	14	11	13	86	51	9	194	194	1	---	---	---
12. TY IVY	13	10	22	107	61	18	225	190	11	465	422	7
13. TS KIM	47	39	6	103	24	2	---	---	---	---	---	---
14. TS LUCY	47	27	10	126	98	6	---	---	---	---	---	---
15. TY MARY	32	23	46	138	98	38	242	186	24	368	267	15
16. TD 15	49	42	5	203	186	1	---	---	---	---	---	---
17. TS NADINE	47	23	13	229	84	9	316	41	2	---	---	---
(CENTRAL PACIFIC HURRICANE CENTER)												
19. TY POLLY	17	13	31	160	106	27	320	215	19	367	233	11
20. TD 20	36	23	6	375	275	2	---	---	---	---	---	---
21. TS ROSE	19	12	13	198	105	9	315	261	4	---	---	---
22. TY SHIRLEY	14	10	20	116	75	16	265	137	9	521	350	5
23. TS TRIX	15	12	5	114	38	1	---	---	---	---	---	---
24. TY VIRGINIA	18	12	15	169	145	11	640	616	1	---	---	---
25. TS WENDY	19	14	24	136	104	20	310	278	11	526	452	4
26. TY AGNES	19	12	24	100	73	20	231	140	16	410	249	12
27. TY BESS	24	9	20	81	42	16	149	85	12	243	85	8
28. TY CARMEN	18	12	21	103	40	17	172	115	10	249	186	7
29. TY DELLA	13	9	25	127	89	21	373	250	16	714	477	7
30. TY ELAINE	14	9	29	94	75	25	158	97	18	250	152	14
31. TS FAYE	22	11	13	92	30	9	181	69	2	---	---	---
32. TY GLORIA	17	12	27	160	103	23	220	166	18	275	197	14
33. TS HESTER	22	16	5	48	48	1	---	---	---	---	---	---
34. TY IRMA	15	9	44	90	62	40	217	168	30	459	318	26
35. TS JUDY	48	37	5	146	146	2	---	---	---	---	---	---
36. TS KIT	34	24	14	71	55	10	128	124	5	206	196	5
ALL FORECASTS	23	15	627	120	78	483	226	157	271	348	245	172
*TYPHOONS	19	13	364	114	75	374	218	150	222	351	243	151

\*Includes only forecasts on cyclones that became typhoons and only when verifying best track wind was 35 kt.

can be seen from the five year mean that position forecast errors have asymptotically approached the 100-200-300 nm plateaus for the forecast intervals. Error statistics for individual cases are listed in detail in sections 3 and 4 below for various categories of storms, and are summarized in Table 5-2.

In addition to the methods described above for verifying absolute error distance (vector error), a computation of closest distance to the best track (right angle error) is also calculated. Right angle error, graphically depicted in Figure 5-2, is a measure of ability to forecast the path of motion without regard to speed.

#### b. INTENSITY FORECAST VERIFICATION

Intensity verification statistics for tropical cyclones meeting criteria (1) above are found in Table 5-3. Increased understanding of relationships between minimum sea level pressure and surface winds and improvements in estimating surface wind from measured flight level wind have resulted in a significantly lower error for the initial (warning position) error for 1974. The more accurate initial intensity, combined with careful application of the Dvorak model and known intensity trends, resulted in significantly reduced intensity errors at all forecast intervals for the past season.

TABLE 5-3. JTWC ANNUAL AVERAGE INTENSITY FORECAST ERROR FOR TYPHOONS WHILE WIND OVER 35 KNOTS

	WARNING POSITION	24-HR	48-HR	72-HR
1971	7.1	15.8	20.7	23.8
1972	8.6	13.5	19.7	23.8
1973	6.5	16.0	20.4	28.4
1974	4.4	11.0	15.4	19.5
AVG	7.0	14.0	19.2	23.4

## 2. COMPARISON OF OBJECTIVE TECHNIQUES

#### a. GENERAL

Objective techniques have been verified annually since 1967, however year-to-year modifications and improvements prevent any long term comparisons of the various techniques. The dynamic objective forecast techniques all employ the steering concept of a point vortex in a smoothed

large-scale flow field. The analog technique provides two movement forecasts, one for those analog storms which recurved and another for non-recyclers as well as an intensity forecast for each. An intensity forecast scheme based on statistical regression equations was evaluated during 1974, and will be used operationally in 1975.

#### b. DISCUSSION OF OBJECTIVE TECHNIQUES:

(1) EXTRAPOLATION - Past 12-hour movement derived from current warning position and 12-hour old preliminary best track position is linearly extrapolated to 24 and 48 hours.

(2) MOHATT 700/500 - Steering program which advects a point vortex on a pre-selected analysis or prognostic SR (space mean) field at the designated upper levels in six-hour time steps through 72 hours. Utilizing the previous 12-hour history position, MOHATT computes the 12-hour forecast error and applies a bias correction to the forecast position.

(3) TYMOD 12/24 - Steering program which advects a point vortex using FNWC Monterey's global band upper-air prognostic fields out to 72 hours. Forecasts are provided for no history, 12-hour history and 24-hour history. Bias corrections are applied based on 12-hour and 24-hour forecast errors determined from the history positions.

(4) TYFOON - 73 - Analog program which scans history tapes for storms similar (within a specified acceptance envelope) to the storm in question. The history tapes are divided into storms which recurved and those which moved generally towards the west. Two 72 hour forecasts are thus provided, and, based on many other considerations, the appropriate one chosen. The TYFOON 73 program also provides analog intensities out to 72 hours.

(5) FCSTINT - Intensity forecast program which utilizes statistical regression equations to provide forecasts out to 72 hours.

#### c. TESTING AND RESULTS:

It is of some interest to compare the performance of the objective techniques to each other and to the official forecast as well. This information is listed in Table 5-4 for typhoons only and in Table 5-5 for all forecasts. Care must be exercised in interpreting the results for the TYFS and TYFR (TYFOON-73 for straight and recurve data tapes), since both outputs were considered for each forecast. Because of procedural changes in the numerical model that TYMOD and MOHATT employ, these techniques continue to exhibit poor performance in the mean at each forecast interval. Research is currently planned to develop a new steering technique designed to eliminate these problems.

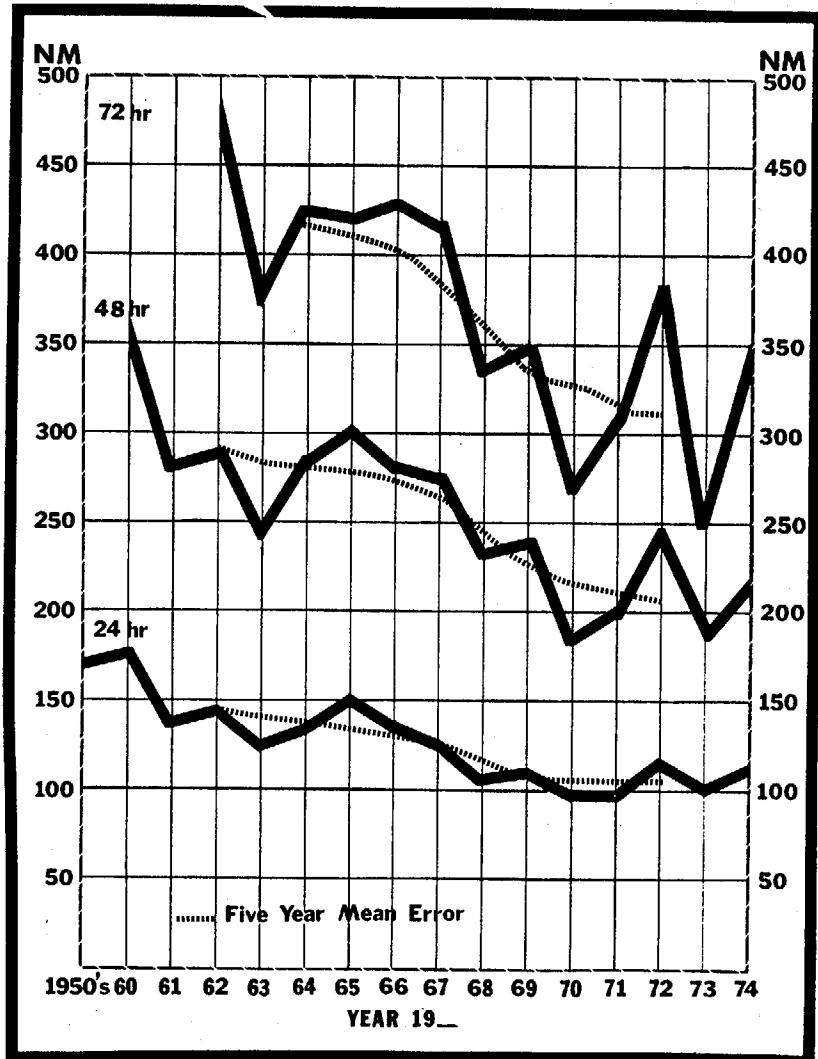


FIGURE 5-1. Mean vector error.

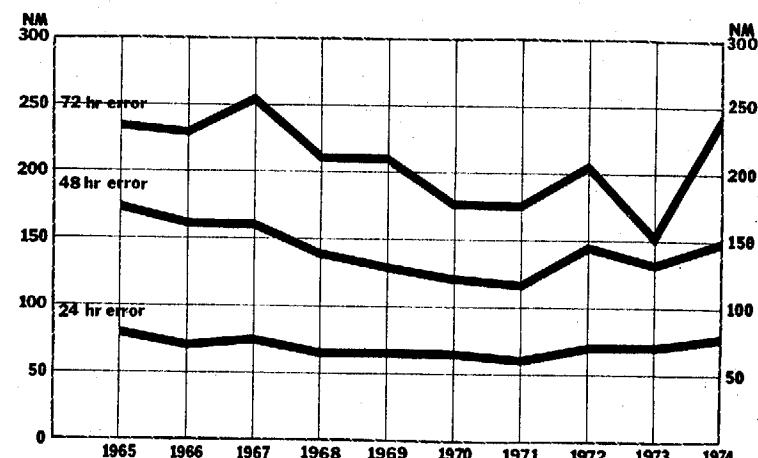


FIGURE 5-2. Mean right angle error.

TABLE 5-4. 1974 OBJECTIVE TECHNIQUES FOR TYPHOONS ONLY (see criterion a)

**24-HOUR**

JTWC	XTRP	TY12	TY24	TYFS	TYFR	MH70	MH50	
JTWC 524 114 114 0								
XTRP 308 116 125 7	308 125 123 0							
TY12 189 120 189 69	179 126 182 56	189 189 189 0						
TY24 181 120 204 84	171 126 201 75	179 182 204 22	181 204 204 0					
TYFS 283 112 124 12	268 121 122 2	177 186 128 -57	168 205 123 -82	283 124 124 0				
TYFR 288 118 114 26	273 124 144 20	181 189 145 -45	172 207 144 -65	273 125 143 18	288 144 144 0			
MH70 242 119 150 32	230 125 147 22	164 191 149 -42	157 211 144 -67	224 127 148 22	229 146 152 6	242 150 150 0		
MH50 235 120 149 29	222 127 146 19	161 189 147 -45	154 213 142 -69	217 128 148 19	221 146 149 3	235 149 147 -4 149 0		

**48-HOUR**

JTWC	XTRP	TY12	TY24	TYFS	TYFR	MH70	MH50	
JTWC 222 218 218 0								
XTRP 222 217 226 9	231 228 228 0							
TY12 135 214 412 197	133 229 394 165	147 407 407 0						
TY24 127 217 409 192	129 229 405 176	138 387 408 21	141 405 405 0					
TYFS 217 217 213 -4	215 228 214 -14	142 401 231 -171	134 402 223 -179	233 223 223 0				
TYFR 215 220 283 63	213 230 287 56	145 410 299 -111	137 410 300 -110	226 221 286 65	233 292 292 0			
MH70 176 221 316 95	175 234 313 79	128 405 315 -89	121 421 316 -105	183 224 316 93	185 297 319 22	191 317 317 0		
MH50 166 225 382 157	166 237 382 146	124 403 388 -15	118 420 386 -35	174 225 380 155	177 298 388 90	181 319 384 65	181 384 384 0	

JTWC - OFFICIAL JTWC SUBJECTIVE FORECAST  
 XTRP - EXTRAPOLATION  
 TY12 - TYMOD WITH 12-HR HISTORY  
 TY24 - TYMOD WITH 24-HR HISTORY  
 TYFS - TYFOON (WEIGHTED CLIMO) STRAIGHT  
 TYFR - TYFOON (WEIGHTED CLIMO) RECURVE  
 MH70 - MOHATT 200-NB PROG  
 MH50 - MOHATT 500-NB PROG

**72-HOUR**

JTWC	TY12	TY24	TYFS	TYFR	MH70	MH50
JTWC 151 351 351 0						
TY12 93 351 588 237	105 615 615 0					
TY24 88 365 612 247	97 592 600 7	102 613 615 0				
TYFS 146 348 271 -77	103 621 325 -296	98 620 314 -306	173 296 296 0			
TYFR 144 350 442 91	101 628 500 -128	96 624 507 -117	169 294 495 201	170 493 493 0		
MH70 121 352 525 173	91 638 580 -58	86 640 590 -50	134 316 577 261	134 492 579 88	159 573 576 0	
MH50 113 360 747 387	88 639 744 105	84 645 751 106	127 308 750 442	127 470 752 282	130 569 749 180	130 749 749 0

TABLE 5-5. 1974 OBJECTIVE TECHNIQUES FOR ALL FORECASTS (see criterion b)

**24-HOUR**

JTWC	XTRP	TY12	TY24	TYFS	TYFR	MH70	MHSO
JTWC 481 120 120 0							
XTRP 425 117 132 14	425 132 152 0						
TY12 267 130 197 67	253 137 192 55	267 197 197 0					
TY24 258 131 218 87	247 137 208 71	255 191 219 27	258 218 218 0				
TYFS 362 117 134 17	342 128 129 0	233 192 135 -57	225 212 131 -81	362 154 134 0			
TYFR 372 122 152 30	352 151 148 17	242 194 149 -45	231 215 149 -65	350 136 151 16	372 152 152 0		
MH70 325 125 160 35	306 152 157 25	228 195 157 -38	219 222 154 -68	286 130 159 28	296 147 161 13	325 160 169 0	
MHSO 507 125 151 25	292 132 148 16	219 194 148 -46	210 222 145 -79	278 132 149 17	287 149 150 2	525 161 149 12	507 151 151 0

NUMBER OF CASES	X-AXIS TECHNIQUES ERROR
Y-AXIS TECHNIQUE ERROR	ERROR DIFFERENCE Y-X

**48-HOUR**

JTWC	XTRP	TY12	TY24	TYFS	TYFR	MH70	MHSO
JTWC 272 226 226 0							
XTRP 257 225 243 20	288 249 249 0						
TY12 159 225 438 215	174 257 450 172	192 435 435 0					
TY24 149 225 436 213	168 259 145 184	180 419 445 26	184 440 440 0				
TYFS 244 222 222 -0	256 238 225 -15	176 425 237 -188	166 430 230 -200	279 238 238 0			
TYFR 244 225 284 59	257 242 288 46	183 433 503 -130	172 439 303 -136	272 237 294 57	283 299 299 0		
MH70 201 222 535 108	215 245 334 88	164 425 542 -83	154 448 343 -105	219 227 357 110	225 296 338 42	235 339 339 0	
MHSO 190 230 584 154	205 244 377 155	157 422 366 -54	148 445 365 -79	210 228 375 147	217 297 381 85	222 341 379 38	222 379 379 0

JTWC = OFFICIAL JTAC SUBJECTIVE FORECAST  
 XTRP = EXTRAPOLATION  
 TY12 = TYMOD WITH 12-HR HISTORY  
 TY24 = TYMOD WITH 24-HR HISTORY  
 TYFS = TYFCON (WEIGHTED CLIMO) STRAIGHT  
 TYFR = TYFCON (WEIGHTED CLIMO) RECURVE  
 MH70 = MOHATT 700-MB PROG  
 MHSO = MOHATT 500-MB PROG

**72-HOUR**

JTWC	TY12	TY24	TYFS	TYFR	MH70	MHSO
JTWC 172 348 348 0						
TY12 99 350 595 246	129 646 646 0					
TY24 94 362 616 253	120 626 629 3	125 639 639 0				
TYFS 156 351 288 -64	123 648 330 -318	118 646 321 -326	199 319 319 0			
TYFR 153 352 441 89	123 660 505 -154	117 652 511 -141	194 316 497 181	197 497 497 0		
MH70 130 353 579 226	113 670 618 -53	107 669 626 -43	157 532 622 290	158 496 606 110	165 620 620 0	
MHSO 122 361 737 376	109 672 700 28	104 674 704 30	150 326 732 407	151 478 730 252	155 616 731 115	155 731 731 0

























## TYPHOON GLORIA

0000Z 03 NOV TO 1200Z 09 NOV

BEST TRACK	WARNING				24 HOUR FORECAST				48 HOUR FORECAST				72 HOUR FORECAST			
	POSIT	WIND	POSIT	WIND	POSIT	WIND	POSIT	WIND	POSIT	WIND	POSIT	WIND	POSIT	WIND	POSIT	WIND
030000Z 7.3N 141.3E 45 7.3N 141.2E 30 6 -5 8.0N 138.4E 45 94 -15 --- --- -- -- -- -- -- -- -- -- -- -- -- -- -- --																
030000Z 7.5N 140.0E 45 7.7N 140.5E 45 13 0 8.4N 135.9E 65 210 0 6.9N 130.7E 85 426 -10 10.8N 125.9E 45 340 -5																
031200Z 7.9N 139.7E 50 7.9N 139.7E 50 0 0 9.2N 135.9E 65 259 -5 10.7N 131.7E 85 362 0 12.4N 127.4E 100 314 -10																
031600Z 9.0N 138.7E 55 8.2N 138.8E 50 48 -5 9.1N 134.9E 65 343 -20 10.2N 130.6E 85 378 0 11.9N 126.1E 100 374 -20																
040000Z 10.3N 137.9E 60 10.1N 137.9E 55 12 -5 12.3N 133.5E 70 232 -30 13.8N 129.3E 85 196 -5 15.1N 125.4E 100 279 5																
040000Z 11.8N 136.9E 65 11.1N 136.7E 60 42 -5 13.7N 131.9E 80 176 -15 15.5N 127.7E 95 119 -5 17.0N 123.9E 110 243 30																
041200Z 13.5N 135.4E 70 13.3N 135.6E 75 17 5 17.6N 131.5E 110 199 25 19.8N 127.4E 115 231 5 21.1N 123.6E 90 316 15																
041600Z 14.7N 133.6E 85 14.7N 133.5E 80 6 -5 17.4N 126.0E 115 111 30 18.9N 120.2E 95 190 -25 20.6N 115.8E 75 167 5																
050000Z 15.6N 131.4E 100 15.6N 131.2E 85 12 -15 17.5N 124.0E 115 154 25 14.8N 119.3E 95 136 0 19.6N 114.9E 80 164 20																
050000Z 16.0N 130.0E 95 16.1N 130.4E 105 6 10 18.2N 124.0E 125 126 25 19.2N 120.1E 100 68 20 19.5N 115.9E 85 111 30																
051200Z 15.9N 128.5E 85 16.2N 128.4E 100 19 15 17.3N 121.4E 85 184 -25 18.5N 116.1E 70 159 -5 19.8N 111.3E 55 346 5																
051600Z 15.7N 127.4E 85 16.0N 127.2E 90 21 5 16.0N 121.4E 80 136 -40 16.0N 116.0E 65 227 -5 16.8N 110.7E 50 468 10																
060000Z 15.9N 126.7E 90 15.6N 126.3E 85 29 -5 15.4N 122.0E 80 152 -15 15.4N 117.9E 55 269 -5 15.8N 114.2E 70 409 35																
060000Z 16.5N 125.9E 100 16.6N 125.7E 110 13 10 18.1N 122.0E 100 125 20 19.1N 118.4E 85 111 30 20.1N 115.2E 65 147 35																
061200Z 17.0N 124.6E 110 17.2N 124.8E 110 17 0 19.3N 120.8E 100 120 25 20.4N 116.7E 90 71 40 21.4N 113.0E 70 178 40																
061600Z 17.5N 123.2E 120 17.5N 123.1E 115 6 -5 18.6N 118.0E 75 45 5 19.3N 113.9E 85 233 45 --- --- --- --- --- --- --- ---																
070000Z 17.9N 121.5E 95 18.1N 121.5E 100 12 -5 19.3N 116.2E 85 97 25 20.6N 112.3E 75 26H 40 --- --- --- --- --- --- --- ---																
070000Z 18.1N 119.9E 80 18.4N 120.0E 85 21 5 19.6N 115.2E 90 140 35 21.2N 111.0E 65 264 35 --- --- --- --- --- --- --- ---																
071200Z 18.4N 118.9E 75 18.5N 119.0E 85 8 10 19.8N 114.8E 80 168 30 21.0N 111.7E 60 249 30 --- --- --- --- --- --- --- ---																
071600Z 19.1N 118.3E 70 18.7N 117.9E 90 33 20 20.1N 113.8E 75 208 35 --- --- --- --- --- --- --- ---																
080000Z 19.9N 117.8E 80 19.1N 117.8E 70 12 10 22.0N 117.1E 40 45 5 --- --- --- --- --- --- --- --- --- --- --- --- --- ---																
080000Z 20.7N 117.4E 55 20.5N 117.5E 60 13 5 23.0N 117.5E 40 108 10 --- --- --- --- --- --- --- --- --- --- --- --- ---																
081200Z 21.5N 117.2E 50 22.0N 117.2E 50 30 0 26.0N 117.4E 20 238 -10 --- --- --- --- --- --- --- --- --- --- --- ---																
081600Z 21.9N 117.0E 40 22.2N 116.7E 45 51 5 --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ---																
090000Z 22.2N 116.4E 35 22.4N 116.7E 35 13 0 --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ---																
090000Z 22.3N 116.4E 30 22.3N 116.4E 40 0 10 --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ---																
091200Z 22.2N 116.1E 30 22.2N 116.0E 30 6 0 --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ---																

## TYPHOONS WHILE WIND OVER 35KTS

WARNING	24-HR	48-HR	72-HR	
AVERAGE FORECAST ERROM	18NM	150NM	215NM	294NM
AVERAGE NIGHT ANGLE ERROM	13NM	97NM	150NM	204NM
AVERAGE MAGNITUDE OF WIND ERROM	6KTS	21KTS	15KTS	16KTS
AVERAGE BIAS OF WIND ERROM	2KTS	6KTS	8KTS	10KTS
NUMBER OF FORECASTS	25	21	16	12

## ALL FORECASTS

WARNING	24-HR	48-HR	72-HR
17NM	160NM	220NM	275NM
12NM	103NM	166NM	197NM
6KTS	20KTS	17KTS	19KTS
2KTS	5KTS	10KTS	14KTS
27	63	18	14

